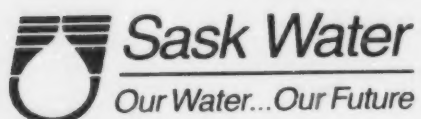


Saskatchewan Municipal Water Supply, Treatment and Distribution Systems

A Technical Assessment



Executive Summary

Sask Water has undertaken an assessment of the status of municipal water systems and in consultation with other agencies initiated the development of longer-term strategies to further reduce risks involved with drinking water. While long-term strategies are still being developed, the technical assessment is now complete and forms the basis of this report.

The following sections discuss each of these objectives in detail, describe the assessment's limitations and summarize the report's conclusions.

To support the assessment, Sask Water designed and implemented a Drinking Water Database. The database sources and analyses information from existing Sask Water and SERM databases and various reports.

An attempt was made to apply a model used by the U.S. Environmental Protection Agency that applies probabilities and weights to the various factors so a relative protection index can be determined for each community. The safety of a drinking water supply can be characterized by four primary factors: water source characteristics and vulnerability, capability of treatment plant processes, operations and maintenance controls and procedures and the quality of the treated water. The model requires data to characterize these factors to develop a community rating of the level of protection provided. However, it was concluded that although the model shows promise for future application, the results were not used in this study due to the lack of suitable data in existing data bases.

Investigation of Needs and Cost Estimates For System Improvements

Sask Water and engineering consultants undertook water system studies at 64 representative Saskatchewan communities. The sample used a cross section of communities to reflect the distribution of communities across the province. Ten cities were also asked to submit information on a voluntary basis. The needs and cost results from these studies were compiled to provide an estimate of the needs and cost of infrastructure (raw water supply, water treatment facility, treated water storage, and treated water distribution) improvements to reduce health risks associated with drinking water.

As part of the assessment Sask Water also sampled the raw and treated water supplies for each of the 64 communities for over 30 constituents. This data was added to Sask Water's data base.

Assessment and Cost Estimates for Improved Quality Management

Quality management is important for the consistent production of high-quality drinking water. Essentially, quality management is a holistic approach to planning, organizing and understanding the interactions of activities impacting the quality of water.

Sask Water performed evaluations of quality management practices at 44 representative communities. The results provided a foundation for assessment of treatment facilities' existing quality management practices, the major deficiencies and the measures and cost estimates for implementation of the most important quality management practices. For example, for these 44 communities, costs for proper water quality testing equipment, spare parts for disinfection equipment, minor repairs, and alarms needed for a quality management system are estimated at \$24 per person. Investments in quality management offer the greatest return.

Report Limitations

The technical assessment report requires careful interpretation due to the following limitations:

- Future drinking water objectives may be more stringent and include more testing parameters and monitoring requirements may change. The current capital costs were estimated based on the existing health-related municipal drinking water quality objectives and the study of 64 community systems. In addition, potential offsetting effects should be considered such as more cost-effective solutions and the adoption of future technologies.
- Innovation may make it possible to provide safe drinking water at a lower cost in the future. Costs for upgrades to community systems are based on currently-accepted technology: each community has a water treatment plant and distribution system. This report does not consider water delivery options such as alternate sources, water hauling, dual systems, pipelines, regional systems and new technology.
- The quality management practices considered in the report are focused at the community level. The assessment of opportunities for improving quality management does not consider the benefits of watershed and water source protection or treatment facility operation alternatives.

Report Conclusions

Four conclusions have been drawn from the technical assessment report.

1. Quality management is central to communities to ensure delivery of quality drinking water. Basic equipment and processes that underpin quality management were found lacking in most of the 44 communities studied.
2. Based on an assessment of a sample of 64 representative communities, it is estimated that over 90 per cent of all communities with a population under 1,000 require upgrades to their infrastructure and quality management to meet health-related drinking water objectives.
3. Over 30 per cent of the cost of infrastructure upgrades applies to communities with populations less than 500 (totaling 50,000 people).
4. Per capita cost for upgrades ranges from \$600 to \$2800 depending on the size of the community and the source of the water supply.

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1 Introduction

Over the past year national attention has focused on the safety of drinking water supplies. This was due largely to the Walkerton, Ontario incident where the health of the residents was compromised due to the contamination of the supply by E. coli. Subsequent to that, most jurisdictions undertook reviews of the safety of their drinking water supplies. The government of Saskatchewan has also been active for the past year on various initiatives to improve the safety of its drinking water supplies and, through the involvement of a number of agencies including Environment and Resource Management, Health, Municipal Affairs and Housing and Sask Water, has been working on the development of a long-term strategy. In support of this strategy, Sask Water undertook an assessment of the status of municipal water supplies.

In Saskatchewan, management of drinking water is a shared responsibility between various government agencies.

- Environment and Resource Management (SERM) has the primary role in setting drinking water quality standards, approving construction and regulations for all municipal facilities and those private works with a water flow greater than 18 cubic metres per day. SERM in consultation with the health districts, also issues drinking water advisories.
- Health operates the provincial laboratory and does most bacteriological analyses for the communities. Health sets standards and guidelines for all private water systems that have a flow of less than 18 cubic metres per day. The health districts are responsible for implementation of the standards and guidelines as set by the department of Health, for those private systems that have a flow of less than 18 cubic metres per day. The district is also responsible for issuing Boil Water Orders, in consultation with SERM.
- Municipalities and other system owners are responsible for collection of water quality analyses and, as owners of the systems, must ensure the system is operated in accordance with provincial approvals.
- Sask Water is a Crown corporation responsible for water management in the province and approves water use and the design of all water works including water treatment plants. Sask Water also owns and operated a number of regional utilities that supply water to about 3.5 per cent of the population.

The Sask Water assessment does not include the roughly 1,500 small public systems such as roadside restaurants, gas stations or resort villages administered by Sask Health, 35 Northern communities, First Nations reserves, and the approximately 150,000 people who rely on private systems on farms and acreages.

First Nations' reserves are the responsibility of the Federal government. Sask Water, at the request of the Department of Municipal Affairs and Housing, is currently reviewing the municipal systems for the 35 northern communities under a separate activity that will lead to the eventual upgrading and improvement of those systems. Appendix A contains a list of the assessed communities.

Sask Water's primary objective in its technical assessment was to conduct an assessment of the status of municipal and other public water systems. In this report, the *system* means both the physical (concrete, steel controls, etc.) and the process (maintenance and monitoring practices, data management and other quality management attributes) aspects. However, the system was confined to those aspects under the control of the community and did not include things like regulatory controls, compliance monitoring, etc. The *assessment* considered the effectiveness of the treatment plant (quality of the water) infrastructure deficiencies and quality management practices with respect to the treatment plant operation. The assessment did not include suitability of existing water quality guidelines, regulatory requirements, population health issues, historical policy or municipal leadership issues which would need to be addressed in a comprehensive assessment of the provinces drinking water system.

The original purpose of the technical assessment was to support the development by a number of agencies of a long-term strategy for drinking water protection in the province. However, while this assessment was in progress, the inquiry into the North Battleford water contamination was established. Based on the commission's terms of reference, it is possible the inquiry may have to delve into issues that would ultimately have implications for all provincial municipal systems. Consequently, government does not wish to proceed in the short term with measures that could be seen to be in conflict with possible recommendations from the commission. The full development of a long-term strategy was temporarily suspended pending the outcome of the inquiry.

When the inquiry report is complete, Sask Water will proceed in co-operation with other agencies to develop a long-term strategy that will consider – in addition to those matters addressed in this report – such things as legislation changes, new regulatory measures, roles of operators, responsibilities of various government agencies, watershed protection plans, water pricing and grant funding.

2 Investigation of Needs and Cost Estimates for System Improvements

2.1 Introduction

To report on the status of municipal drinking water systems in the province, Sask Water undertook an assessment of a sample of communities following a general approach used by the United States Environmental Protection Agency. The USEPA regularly samples approximately seven per cent of the communities as a representative sample of the entire population of communities in the country. In this case, Sask Water identified a sample of 64 communities to use as a representative sample for the province.

To confirm the representativeness of the sample, the USEPA also applies a model that analyses data compiled on each community. This model provides a characterization of the level of protection that each community is providing. Sask Water wanted to also try and use this model so the general level of protection provided by the population of communities could be compared to the detailed needs assessment of the 64 communities. However, in attempting to apply the model it became evident that the current data base on communities is not comprehensive enough to use the model results in a meaningful way. Nevertheless the model shows considerable promise as a means to be able to evaluate the level of protection provided by a municipal system. A further description of the model can be found in Appendix F.

Municipal drinking water system assessments were undertaken to provide an estimated cost of system improvements to meet Saskatchewan municipal drinking water quality objectives. The assessment of the existing infrastructure needs included an investigation of raw water supply, water treatment, treated water storage and distribution components of municipal systems.

2.2 Methodology

To support the assessment, Sask Water designed and implemented a Drinking Water Database. The database sources and analyses information from existing Sask Water and SERM databases and various reports. The data base was assembled using existing information and data gathered through a mail survey of communities (see Appendix B). Appendix C shows a blank and a sample record from the database.

The ESQUADAT database is the primary database maintained by SERM. All compliance monitoring done by communities of their treated supplies as stipulated in their Minister's Orders is entered onto this database. Monitoring by SERM as part of their inspection responsibilities is also entered.

Sask Water has undertaken special sampling for the 35 northern communities and sampling for a number of potential utility development projects. This data was added to the Sask Water database.

The assembled data for each community tends to be highly variable as to the range of constituents sampled. To support the needs assessment study, Sask Water also sampled source (raw) and treated water supplies for each of the 64 communities for which detailed needs investigations were completed. These communities represent a uniform cross section by population, plant capacity and geographic location. They also proportionately represent the provincial distribution between surface water and groundwater sources.

Samples were collected from the raw water supplies and analysed for a broad range of constituents including major ions, trace metals, nitrate, dissolved organic carbon, and bacteria. The health parameters tested included nitrate, mercury, arsenic, barium, boron, cadmium, chromium, lead, selenium, fluoride, turbidity, uranium, total coliform, faecal coliform and E. coli.

The analysis of the raw water samples for 64 communities showed that 92 per cent exceeded one or more health-related parameters with 74 per cent, including many groundwater sources, exceeding the turbidity guideline. This comparison with health-related parameters was done to assist with the determination of the treatment requirements for the raw supply. The health parameters most frequently exceeded included turbidity, bacteria, arsenic and nitrate. Based on this sample, it would appear prudent for a number of communities to improve their testing and reporting to monitor these parameters.

Municipal treatment systems in Saskatchewan were grouped into six categories of peak day water demands. The peak day water demand is equivalent to the maximum treatment plant water production between 1995 and 1999 inclusive. The 513 systems were divided into six flow-rate categories to assist in the costing model. Each of the six categories were also divided into groundwater and surface water sources. This assisted in making the cost model more accurate. The peak day demand categories and associated population groups are outlined in Table 1.

Table 1: Water demand and population groups

Group	1	2	3	4	5	6	All
Peak Day Water Demand l/s	0 to 1.0	1.0 to 2.5	2.5 to 6.0	6.0 to 15.0	15.0 to 100.0	Over 100.0	N/A
Number of Communities	129	118	107	105	44	10	513
Number of Groundwater Communities	90	93	82	82	26	1	374
Number of Surface Water Communities	39	25	25	23	18	9	139
Approximate Population Range	1 to 100	101 to 200	201 to 500	501 to 1,000	1,001 to 10,000	over 10,000	n/a
Total 1996 CC Population	6387	12421	30808	70619	93860	525320	739415

A sample of communities was selected from each group for a total sample of 64 communities. Over the past six years, Sask Water performed studies on 29 of these communities as part of its Water and Wastewater Utility Development Program. Consultants were retained to provide the 35 additional evaluations. The studies included a field evaluation and an office study to determine type and cost of works required for renovation.

Upgrade needs and costs within the 10 largest communities were evaluated by a mail survey. The 35 northern communities currently being evaluated and upgraded by Sask Water and SMAH were not included within the cost estimates.

Capital upgrade cost estimates comprise incremental upgrade work to existing drinking water systems needed to allow communities to produce drinking water that meets health-related water quality parameters. The cost estimate does not include any capacity increase over the present conditions.

Cost estimates include project management costs and a 30 per cent contingency.

2.3 Results

Results are presented for the sample of 64 communities. The components used to break down system needs included: raw supply system, water treatment facility, treated water storage and water distribution. The communities were grouped into five groups, each with communities possessing similarly-sized systems flow rates and system management issues. The estimated infrastructure upgrade needs are presented in Table 2.

Table 2: Upgrade Needs For 64 Community Sample

Group	1	2	3	4	5
Population Range	1 to 100	101 to 200	201 to 500	501 to 1,000	1,001 to 10,000
Total Number of Communities	129	118	107	105	44
Total Number of Sample Communities	13	14	15	12	10
% Requiring Upgrade to Raw Supply System	50%	69%	63%	60%	50%
% Requiring Upgrade to Water Treatment Facility	92%	100%	81%	100%	88%
% Requiring Upgrade to Treated Water Storage	25%	62%	56%	47%	75%
% Requiring Upgrade to Water Distribution	83%	77%	31%	20%	50%

The following table breaks down the capital upgrade cost by five flow categories. These costs have been adjusted for the 2001 Canada/Saskatchewan Infrastructure Program spending.

Table 3: Capital Upgrade Cost Estimate by Flow Rate and Community Size

Group	1	2	3	4	5	Total
Flow Range (litre/sec)	0 to 1.0	1.0 to 2.5	2.5 to 6.0	6.0 to 15.0	15.0 to 100.0	
Population Range	1 to 100	101 to 200	201 to 500	501 to 1,000	1,001 to 10,000	
Total Number of Communities in the Province	129	118	107	105	44	503
Total 1996 CC Population	6387	12421	30808	70619	93860	214095
Flow for 64 Studied Communities (litre/sec)	7.5	30.4	69	139.7	267.5	514.1
Upgrade Cost for 64 Communities (\$ M)	\$1.7	\$2.40	\$9.40	\$19.0	\$10.7	\$43.2
Per capita cost	\$3000.0	\$2000.0	\$2000.0	\$2000.0	\$600.0	NA

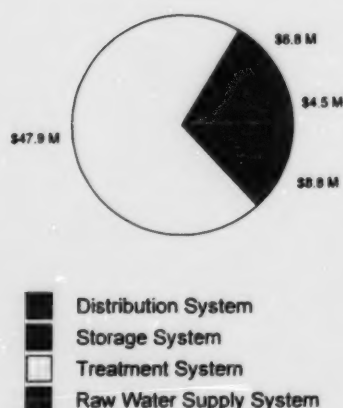
In addition to the 64 communities sampled, the 10 largest cities provided municipal infrastructure costs. The cities of North Battleford, Weyburn, Estevan and Swift Current provided estimates to Sask Water showing \$24 million in upgrades to meet health-related drinking water quality objectives (does not include 2001 improvements to the City of North Battleford). The cities of Prince Albert, Saskatoon, Regina, Moose Jaw, Yorkton and Lloydminster provided costs that were deemed not to be required to meet health-related water quality objectives. Therefore, these costs were not included.

These cost estimates are based on the community undertaking improvements to meet current health-related guidelines on a consistent basis. However, these guidelines are under regular review and as more scientific evidence is accumulated, the trend is generally to lower the acceptable concentration of the constituent. In Canada the arsenic guideline has recently been lowered from 50 micrograms per litre to 25 micrograms per litre. In the U.S. it has been recommended that the standard be lowered from 50 to five micrograms per litre. Because this is established as a standard, communities across the U.S. will be subject to significantly increased capital and operating costs. The level at which the standard will be set is still a matter of controversy. Similar discussions are underway in Canada with respect to uranium and THMs. The Canadian guideline for THMs has gone from 350 micrograms per litre to 100 and in the U.S. it is 80. The World Health Organization has recommended the guideline be 30 micrograms per litre (Dr. Hans Peterson personal communication, 2001).

The trend is clear and the result will be that the costs to meet future guidelines will likely be significantly more than the current cost estimate.

The following summarizes capital upgrade costs (Figure 1).

Figure 1: Capital Upgrade Cost for 64 Communities and 10 Largest Cities



2.4 Alternatives to Conventional Treatment

This report considers only municipal systems with mainly conventional groundwater and surface water treatment plants. In a few instances, a demineralization treatment process (reverse osmosis) to reduce minerals from highly-mineralized water sources was considered for a community. This report does not address any other treated water supply alternatives. In particular, depending on each community's situation there may be more innovative, cost-effective methods to provide safe drinking water than conventional approaches. Some alternatives that have been used in Saskatchewan or elsewhere are briefly described below. This is not a complete list and the objectives to be achieved with any one alternative could be different. Also, there are possibly many variations on each specific alternative that would reflect local adaptations. For some alternatives to be fully implemented, there may be a need for revised provincial regulations.

The need to address alternatives applies mainly to the relatively small communities where the problems can include deteriorated infrastructure, lack of access to capital, limited customer and rate base, inadequate rates, diseconomies of scale and limited technical and managerial capabilities. The alternative considered might address any or all of the above issues.

Regional Systems

A regional system is a pipeline network supplying treated water to communities, rural groups and industry. The regional system can include a centralized water treatment plant or purchase treated water from a community for distribution. Regional systems provide a long-term solution (40+ years) to provide an ample supply of high quality treated water to users.

Sask Water has successfully owned and operated regional systems for a number of years. These systems include the Melfort Regional Water Supply System, the Wakaw-Humboldt Regional Water Supply System and the Saskatoon Treated Water Supply System. Costs for these systems can be higher than other short-term solutions but the aggregate long-term security benefit provided to an area is valued by the users.

The first step would be to connect communities to existing regional systems, thereby maximizing existing systems.

Secondly, there is potential for regional systems elsewhere in the province to provide long-term drinking water solutions. For example:

- The Yorkton area (including Yorkton, Melville and nearby communities) could be served with a central water treatment plant sourcing water from Lake of the Prairies near Saskatchewan-Manitoba border.
- Similarly, Eston, Kindersley, Kerrobert, Unity, Wilkie and Maidstone areas could be served by a central water treatment plant and supply systems sourcing water from South Saskatchewan or North Saskatchewan Rivers.

Centralized Reverse Osmosis Plants

In a community where the treated water is highly mineralised and is safe for bathing and other usage but not good enough for drinking and cooking, a small central reverse osmosis system could be installed in the existing water treatment plant building or central location. Typically, this type of system would be capable of providing a few gallons of high-quality water per day for each user. Users would have to haul and store the treated water.

The Village of Liberty is an example of a community in which the municipal water system produces treated water with very poor water quality. Residents obtain their drinking and cooking water from a small reverse osmosis system located in the fire hall.

A complete demineralisation system includes a chlorine feeder and a small storage tank. The capital cost per system (or per community) would be only \$15,000 to \$25,000, and the annual operation and maintenance cost is estimated to be \$2,000 to \$4,000.

Individual Reverse Osmosis Systems

Individual systems would be suitable for a community where the treated water is highly mineralized and is safe for bathing and other usage, but not good enough for drinking and cooking (a similar situation to a centralized demineralisation system). An individual treatment system could be installed under the sink in the user's house to provide four to five gallons of treated water a day for drinking and cooking. The system requires that the water is soft and is free from iron and manganese. The capital cost of each individual system would be \$800 to \$2,000, and the annual operation and maintenance cost would be approximately \$200 to \$500.

Proper maintenance and cleaning is essential with these systems because bacteria can grow on the membranes and foul the system.

Dual Systems

Dual systems have two service alternatives or sources for satisfying household water needs. The primary source would supply low volumes of high quality water for drinking, cooking and washing. The secondary source would deliver higher volumes of partially treated or untreated water for toilets, lawns and gardens. Dual systems that provide untreated water can be a health concern for users who inadvertently drink from the secondary source.

Dual systems can include dual pipeline systems, and conventional distribution systems in combination with a centralized reverse osmosis system or individual reverse osmosis systems or treated water hauling.

Dual Pipeline System

Dual pipeline systems deliver high-quality drinking water and partially-treated water for household uses. Typically, these systems are used to defer water treatment plant expansions or to maintain an existing high quality water source. Dual pipeline systems are more feasible for smaller communities.

The Town of Lafleche is an example of a community with a dual pipeline system. Part of the community is served by a shallow buried untreated water pipeline for lawns and gardens.

Treated Water Hauling

Water hauling may be an alternative for communities with no adequate water supplies or in which the cost for treating the existing water supply is too high. Users who haul their water must have a water storage reservoir and pressurization system.

Potential New Solutions

There are 71 of the 503 communities that have a population of 41 or less, some of which consist of only a few households. New solutions will require technologically new, innovative and affordable solutions for smaller and isolated communities. These solutions will have to incorporate design criteria that ensures scalability, portability, low energy consumption and simplicity. There are a variety of new technologies available depending on the specific circumstances of the community, but many of these are untested. The U.S. Environmental Protection Agency publishes a list of alternative technologies for small systems and is working on various studies to verify the technologies. Many of these might have application to systems in Saskatchewan and need to be reviewed.

3 Drinking Water Quality Management

3.1 Introduction

Quality management principles and processes have clear application to Saskatchewan's current drinking water system. Moreover, there are clear signals from the international and Canadian drinking water sector that total drinking water quality management is being adopted as the principal management approach.

The following provides an examination of general principals of quality management, followed by a more detailed assessment of some aspects of quality management in a sample of drinking water systems in Saskatchewan.

3.2 Quality Management Models

Total quality management is an overarching approach to achieving product and service quality. Quality management has a number of attributes including leadership, innovation and learning, and product quality and control. Quality management is an approach to planning, organizing, understanding and managing each system, process and activity implicated in the pursuit of quality drinking water. Therefore, for drinking water quality management to be truly effective, each part of the system must work towards the same goals, recognizing that each activity affects and in turn is affected by other systems, processes and activities in the system. Quality management is considered a means for ensuring that every job in the drinking water quality management chain is carried out right, first time, every time. Simply, total quality management is about performance.

That being said, total quality management incorporates the principle that quality is what the consumer or customer ascribes to drinking water. This follows the noted quality expert Joseph Juran, who stated that until a customer says a product is good, it would not be considered to be of good quality. In other words, the citizen consumer judges drinking water quality. Thus, a drinking water quality management system must take into account all product features and characteristics. This demands customer-driven excellence with constant sensitivity to changing and emerging customer requirements and to the factors that drive customer satisfaction.

Tom Pearson, writing in the Journal of the American Water Works Association (AWWA)¹, states that Total Quality Management (TQM) has revolutionized North American industry in general and is now taking hold in the water industry. He states that using TQM as a means to improve productivity, quality and service will help water utilities address current trends toward customer demand for higher quality water and

¹ Journal American Water Works Association. 92 (1). January 2000.

more and better service.

The AWWA undertook a study in 2000 to identify the top 10 tools for utilities to create customer satisfaction². The operation of five diverse water utilities were examined and a number of common threads identified. These include well-trained staff, a management commitment to customer satisfaction, customer access to information, standard setting, performance measurement and non-stop improvements – many of the same principles commonly cited in total quality management literature.

There are a number of approaches to quality management which vary by their level of generality. The Malcolm Baldrige and Australia/New Zealand models are presented in this assessment incorporating some of the most current thinking on total quality management. They are not presented as models which can be adopted without additional thought and consideration among stakeholders as to their application within the Saskatchewan context. That being said, when taken together they clearly incorporate the majority of principles embedded in a total quality drinking water management approach.

The Malcolm Baldrige Award and the Australia/New Zealand quality management approaches listed here address quality management from an organizational/ corporate point of view. The Australia/New Zealand model tends to be targeted more directly at drinking water organizations while the Malcolm Baldrige Award is more general in that its principles can be ascribed to most organizations/corporations.

Malcolm Baldrige

The Malcolm Baldrige Award is an American national quality award. It is given to the corporation(s) in the U.S. that most reflect quality management principles. Interestingly, Operations Management International (OMI) was awarded the 2000 Malcolm Baldrige Service Award. OMI is an employee-owned drinking water and wastewater firm that operates local utilities in small and medium-sized communities throughout the U.S.

The following is a list of quality management principles and themes adapted from the Malcolm Baldrige Award criteria. They warrant further study and assessment as to their applicability to drinking water quality management and organizations in Saskatchewan.

² Journal American Water Works Association. 92 (11). November 2000.

1. Leadership
 - a. Organizational Leadership
 - b. Public Responsibility and Citizenship
2. Strategic Planning
 - a. Strategy Development
 - b. Strategy Deployment
3. Customer and Citizen Focus
 - a. Customer Knowledge
 - b. Customer Relationships and Satisfaction
4. Information and Analysis
 - a. Measurement and Analysis of Organizational Performance
 - b. Information Management
5. Human Resource Focus
 - a. Work Systems
 - b. Employee Education, Training, and Development
 - c. Employee Well-being and Satisfaction
6. Process Management
 - a. Product and Service Processes
 - b. Business Processes
 - c. Support Processes
7. Performance Results
 - a. Customer-Focused results
 - b. Financial and Market Results
 - c. Human Resource results
 - d. Organizational Effectiveness Results

Australia/New Zealand Framework

Australia and New Zealand are in the process of finalizing a "Framework for Management of Drinking Water Quality." In effect, the Australian/New Zealand Framework seeks to take the general principles of total quality management and apply them more directly to organizations involved in the drinking water system. These principles include:

1. Continuous improvement
 - a. Senior management review
 - b. Total quality management system plan
 - c. Research and development
2. Community involvement and awareness
 - a. Community consultation
 - b. Transparency
 - c. Communication
3. Hazard identification and risk assessment
4. Critical control points
5. Prevention strategies
 - a. Multiple barriers
6. Risk management
 - a. Incident and emergency response protocols
 - b. Incident and emergency response communications
7. Employee awareness and training
 - a. Employee awareness and involvement
 - b. Employee training
8. Standard operating procedures
 - a. Operational procedures
 - b. Equipment capability
 - c. Materials and chemicals
 - d. Operational monitoring
 - e. Operational preventative and corrective action
9. Verification of drinking water quality
 - a. Drinking water quality monitoring
 - b. Short-term evaluation of results
 - c. Corrective action
10. Documentation and reporting
 - a. Documentation and records management
 - b. Reporting
11. Evaluation and audit
 - a. Long-term evaluation of results
 - b. Drinking water quality management audit

3.3 Methodology

As described above, quality management can encompass many components. However, for this part of the assessment, quality management has been considered to include water quality monitoring, treatment surveillance and adjustments, records maintenance, treatment chemicals management, system maintenance, cleaning, communications, and operating protocols at the local drinking water utility level. It was not assessed at the broader system level.

The quality management systems examined in this study include cross connection control, external audits of waterworks, crisis action plans and budget processes. Sask Water, with the assistance of the consulting firm of M.R.2. - McDonald & Associates, undertook the quality management assessment objective of this study. It evaluated quality management at 44 representative communities. The results provide an assessment of existing quality management systems, major deficiencies, and the measures and cost estimates required for implementation of the most important quality management systems.

The quality management study identified quality management features and systems using information gathered by engineering consultants during on-site surveys. A copy of the on-site survey instrument is found in Appendix D of this report.

Survey results were used to assess existing quality management systems, identify major deficiencies, determine required remedial measures and estimate costs for the implementation of the most important quality management systems on a basis. During the assessment, appropriate physical and human resources associated with facilities of different capacities were considered.

There are a number of components associated with site-specific quality management systems. In addition, there are some basic features that are required in terms of health-related drinking water quality and in the broad context of Saskatchewan municipal water systems. Some of these features include:

- Maintenance of proper disinfectant practices and bacteriological quality surveillance.
- Operations and monitoring to ensure compliance with all health-related drinking water quality characteristics in distributed water.
- Suitable site testing equipment, protocols for its use and data reviews.
- Appropriate documentation of facility operating procedures and practices including record keeping and conditions and points or indicators that would trigger an action (such as chemical dosage changes or modifications).
- Operator and support or back-up staff awareness and knowledge.
- Availability of back-up equipment or parts and maintenance of key process and chemical feed systems including treatment chemical inventory management.
- Periods of operations surveillance either through operator attendance or the use of appropriate sensors, alarms, or remote communications systems.
- Protection and cleaning of treated water storage and delivery systems.

3.4 Observations and Analysis

Data relevant to quality management issues was extracted from the Municipal Waterworks Information form completed for 35 communities. This data represented the individual systems and summarized them according to water supply source type and population ranges. To this base, Sask Water incorporated information on nine additional communities to obtain a sample of 44 communities.

Groundwater Systems

The summary for 29 groundwater supply facilities is contained in Table 1, Appendix E. With respect to some of the more important quality management features, the following observations were made:

Testing Equipment

- All had chlorine residual kits.
- Iron, manganese, fluoride, turbidity, colour, pH, alkalinity, and hardness testing equipment was available at some sites. Iron and manganese kits were the most common.
- Only one community in the largest population range had a chlorine residual recorder.

Testing and Records

- Chlorine residuals testing at the plant varied from once per week to twice daily.
- Record keeping is minimal (less than half note site quality testing and dosages).
- Bacteriological testing indicated less than 100 per cent compliance with probable requirements.

Equipment

- Chlorination feeder spares or parts were lacking in the population group of less than 100.

Operations

- Attendance at water treatment plants ranged from monthly to daily and on average, hours at the plants ranged from less than 1 to 3.5 per day.

Surface Water Systems

There were 12 surface water supply systems included in the survey, all grouped in three population ranges. Sask Water augmented these by adding three systems and two population groups. Table 2, Appendix E provides a summary of the quality management related information. Salient observations included:

Testing Equipment

- One facility (population less than 100) showed no chlorine residual test kit.
- Only three sites indicated turbidimeters present.
- None of the facilities had continuous or in-line monitoring equipment.

Testing and Records

- In the smaller (population less than 100) population groups, plant chlorine residuals measurements ranged from daily to monthly.
- Record keeping was generally limited except for water quantities and site testing.
- Bacteriological testing was in general compliance.
- Trihalomethane testing was only indicated at seven sites.
- Bench testing equipment was only present at two sites.

Equipment

- All communities except two appeared to have spares or repair parts for the disinfectant feeder.
- None of the less than 250 population group indicated that spares or parts were on hand for other chemical feeders.
- Only in one instance were feeders calibrated.

Chemical Use

- A coagulant was not always used in two of the five communities with populations of less than 100.
- Generally, a reasonable chemical inventory was maintained.

Protection and Cleaning

- Only two of the five small communities were noted to have satisfactory reservoir manway protection.
- Except for two sites, treated water reservoir cleaning was shown to be within a five-year window.
- Distribution flushing in the small communities was not routine. This is possibly due to small diameter pipes and an absence of fire hydrant systems to facilitate flushing.

Operations

- At two sites of less than 100 population, the availability of back-up operations was not indicated.
- Daily attendance at water treatment facilities was normal, except at communities with populations of less than 100 where the range was daily to weekly.
- At all sites, plant attendance was eight hours or less per day. At communities with populations less than 500, the attendance ranged from less than one hour to three hours per day.

Combination Ground and Surface Water Systems

Three of the examined communities, all with populations greater than 500, use both surface water and groundwater. A summary of their survey information is listed in Table 3, Appendix E. Based on the survey, the following comments are offered:

Testing Equipment

- All three sites had a good spectrum of analytical testing equipment.
- None of the plants had continuous monitors.
- One plant had jar testing capability.

Testing and Records

- Plant testing for key parameters was generally performed at least daily.
- Records appear to be maintained for basic information, except for one community (Sask Water information).

Equipment

- Spares or parts availability was indicated for all chemical feeders.
- One site performs feeder calibrations.

Chemical Use

- It was noted that at all locations, a coagulant was not always being used.
- Reasonable chemical inventories were maintained.

Operations

- Treatment plant attendance at two sites (with information) was indicated as 2.5 to 5 hours per day.

Ground Water Systems Needs Assessment

From the 35-community survey and nine-community augmentation information, needs were identified as a percentage of the population groups. These needs were considered to be essential for water quality management requirements. Table 4 lists the needs for groundwater supply facilities.

Table 4: Basic Quality Management Equipment/Facility Needs Groundwater Supply Facilities

Item	Percentage Need Within Population Group				
	1 to 100	101 to 250	251 to 500	501 to 1,000	1,001 to 10,000
Testing Bench/Sink	75	44	25	50	--
Disinfectant Feeder Spare	88	56	25	17	--
Manway Protection	13	56	25	50	--

Surface and Combined Water System Needs Assessment

The basic quality management equipment/facility needs for surface water systems (including combination surface and groundwater systems) are more complicated with respect to monitoring capability. Parameters such as chlorine residual, turbidity and particle counts can be measured on a continuous basis. However, to be of benefit, these instruments must be properly calibrated and maintained. While the cost aspect may favour installation at larger plants, it does not suggest this type of monitoring is less necessary or desirable at smaller facilities.

For the purposes of this review, the following assumptions are made with regard to surface water supply facilities.

- All plants should use a portable turbidimeter.
- Plants serving a population of greater than 500 should have a minimum of one continuous turbidimeter for treated water, preferably placed on the effluent from each filter.
- Chlorine residual monitors/recorders should be available for plants with a population in excess of 1,000.
- Alarms should be in place for deficient concentrations.
- Alarms and plant production stoppage should be interfaced with the disinfectant feeder in case of malfunctions in smaller facilities.
- Particle count determination is a useful tool and could be installed in larger cities.
- Periodic external analyses would help in smaller communities.
- All communities should have bench testing equipment available for coagulation-flocculation control. Smaller communities may require assistance for testing.
- While it is desirable for chemical (i.e. coagulant) feed control to automatically link to raw water quality, it is best assessed on a site-specific basis.

Table 5 identifies potential needs for surface and combination source supply facilities. Alarms and related control systems were not included in the survey.

Table 5: Basic Quality Management Equipment/Facility Needs Surface and Combination Water Supply Facilities

Item	% Need Within Population Group				
	1 to 100	101 to 250	251 to 500	501 to 1,000	1,001 to 10,000
Chlorine Residual Testing Equipment	20	--	--	--	--
Portable/Bench Turbidimeters	80	100	67	67	--
Continuous Turbidimeters	N/A	N/A	N/A	100	100
Continuous Chlorine Residual Recorders	N/A	N/A	N/A	N/A	100
Testing Bench/Sink	60	100	33	33	33
Bench Testing Equipment	100	100	67	100	33
Disinfectant Feeder Spare	40	100	33	67	--
Other Feeder - Spare/Parts	100	100	--	--	--
Manway Protection	60	100	--	67	--

3.5 Cost Estimates

The following unit costs were used to determine estimates of physical equipment and facilities associated with basic quality management needs.

- Residual chlorine colorimeter - \$ 500
- Portable/bench turbidimeter - 1,500
- Continuous turbidimeter and display - 5,000
- Continuous chlorine residual recorder - 3,000
- Testing bench/sink - 1,000
- Bench testing equipment (jar stirrers) - 2,000
- Spare solution feeder - 1,500
- Miscellaneous feeder parts - 500
- Manway protection - 500
- Alarm/controls (disinfectant feeder) - 5,000

The number of communities (Sask Water data) relative to the survey are as follows:

Table 6: Groundwater and Surface Water Communities

Item	Population Range			
	1 to 100	100 to 500	501 to 1,000	1,001 to 10,000
Groundwater Supply				
Total Number	90	175	82	26
Survey Number	8	13	6	2
Surface Water Supply				
Total Number	39	50	23	18
Survey Number	5	4	3	3

Cost estimates are extrapolated from the basic needs identification and unit cost values. These values are biased by the inclusion of the alarms/control feature for the disinfectant system and the assumption that all communities with populations less than 1,000 would require this safeguard. Further examination of alternative methods and the costs on a site specific basis are warranted.

The foregoing system groupings represent a population of approximately 214,000. The illustrated total cost would result in a per capita expenditure of approximately \$24. This per capita cost incorporates only basic quality management upgrades.

3.6 Conclusion

As was noted in the site specific quality management assessment, variations in comprehensiveness and complexity can be expected. These will occur with respect to the water source, raw water quality and its variability, treatment processes, infrastructure sizing and capacity, and other site-specific characteristics.

Properly protected, groundwater-source systems are typically much less complex than those supplied by surface water. For many Saskatchewan sites, treatment is restricted to disinfection and removal of iron and/or manganese. Provision of adequate disinfection and bacteriologically safe water is the key quality management measure.

Conversely, surface water treatment can pose many more challenges. This is the result of an increase in potential quality issues such as bacteriological and other biological safety, control of particulates (turbidity), and process generated concerns (e.g., trihalomethane and other disinfection byproducts). Source water quality, temporal variations, and susceptibility to potential contaminants may dictate the rigour of control and the quality management implications. Testing, process adjustments and maintenance of key treatment units and barriers such as filters become more complex and intensive. For example, filter operations and maintenance can include continuous

surveillance of effluent quality (turbidity or particle counts), filter media quality and bed maintenance, washing practices and frequencies, filter to waste criteria, and competence of the underdrain systems.

The requirement for the duration and periods of operations surveillance will vary with the consistency of the treatment requirements, the stability of the treatment process train and the use of external communications or alarms in case of equipment malfunctions. In some instances, problems such as loss of a disinfectant feed or a filter failure could warrant an immediate cessation of treated water production.

Water quality testing is carried out for three purposes:

- to identify immediate health risks from microbiological parameters (faecal coliforms)
- to identify long-term health risks associated with extended consumption of various chemicals over a long period of time
- to ensure the effectiveness of the water treatment system (aluminum, hardness, aesthetics)

Moving to a quality management system will also require collection of more water quality data to support ongoing monitoring and evaluation of the level of protection that municipal systems are providing. The USEPA model that Sask Water tried to apply could not produce suitable results due to a lack of data. As part of an implementation of a quality management system will be the identification of the important system parameters that need to be monitored on a regular and ongoing basis.

The approach that this assessment took with respect to the site-specific quality management assessment was limited. Nevertheless, quality management systems can be considered lacking in many Saskatchewan water treatment plants. Therefore, additional analysis of individual drinking water systems flowing from the Technical Report need to include a quality management analysis.

The Malcolm Baldrige and Australian/New Zealand Framework are leading models of total quality management. However, as with most models they need to be adapted to best fit within the Saskatchewan context.

Nevertheless, there is a wide gap between the type of total quality management suggested by the Malcolm Baldrige and Australian/New Zealand models and the level of quality management that is now in place. This is not surprising as the application of total quality management principles and practices to drinking water quality management is relatively new.

Obviously, there is work to be done to close this gap. This should include but not be limited to an examination of leadership and innovation within the drinking water quality system. Also, further work is required in the intersection between value and quality. Quality is the degree of excellence at an acceptable price and the acceptability of variability at an acceptable cost. An important dimension of value and quality then for citizens and their government is that if it is not a question of providing quality at any price, what is the optimization of this relationship?

Another aspect of quality management requiring further work is transparency. Transparency helps ensure public expectations are being met. The public must be able to trust that those involved in supplying them with quality drinking water are doing everything they can to justify this trust.

Appendix A - Assessed Communities

PLACE	1996 Canada Census Population	In-Plant Study For Cost Estimate	Studied for Quality Management
ABBEY	162	No	No
ABERDEEN	474	No	No
ABERNETHY	232	No	No
ADMIRAL	34	No	No
AIR RONGE	957	No	No
ALAMEDA	304	No	No
ALBERTVILLE	122	No	No
ALIDA	158	No	No
ALLAN	702	No	No
ALSASK	237	No	No
ALVENA	79	No	No
AMSTERDAM	31	No	No
ANEROID	81	No	No
ANNAHEIM	214	No	No
ANTLER	64	No	No
ARBORFIELD	437	✓	No
ARCHERWILL	254	No	No
ARCOLA	517	No	No
ARELEE	19	No	No
ARRAN	53	No	No
ASQUITH	533	No	No
ASSINIBOIA	2653	No	No
ATWATER	35	No	No
AVONLEA	402	No	No
AYLESBURY	59	No	No
AYLSHAM	91	No	No
BALCARRES	661	✓	✓
BALGONIE	1132	No	No
BANGOR	57	No	No
BANKEND	27	✓	✓
BATTLEFORD	3936	No	No
BEAR CREEK	47	No	No
BEATTY	87	No	No
BEAUBIER	32	No	No
BEAVAL	785	No	No
BEECHY	281	No	No
BELLE PLAINE	64	No	No
BELLEGARDE	50	No	No
BENGOUGH	488	No	No
BENSON	89	No	No
BETHUNE	375	No	No
BIENFAIT	826	No	No
BIG BEAVER	32	No	No
BIG RIVER	826	No	No
BIGGAR	2351	✓	✓
BIRCH HILLS	945	✓	✓
BIRSAY	58	No	No
BLACK POINT	43	No	No

PLACE	1996 Canada Census Population	In-Plant Study For Cost Estimate	Studied for Quality Management
BLADWORTH	76	No	No
BLAINE LAKE	516	No	No
BORDEN	217	No	No
BRABANT LAKE	72	No	No
BRACKEN	56	No	No
BRADWELL	145	No	No
BRANCEPETH	35	No	No
BREDENBURY	368	No	No
BRIERCREST	125	No	No
BROADVIEW	751	✓	✓
BRODERICK	86	No	No
BROOKSBY	21	No	No
BROWNLEE	72	No	No
BRUNO	648	No	No
BUCHANAN	279	No	No
BUENA VISTA	343	No	No
BUFFALO NARROWS	1053	No	No
BULYEA	99	No	No
BURSTALL	426	No	No
CABRI	529	✓	No
CADILLAC	97	No	No
CALDER	106	No	No
CAMSELL PORTAGE	50	No	No
CANDIAC	22	✓	✓
CANORA	2208	No	No
CANWOOD	345	No	No
CARIEVALE	253	No	No
CARLYLE	1252	No	No
CARMEL	68	No	No
CARMICHAEL	23	No	No
CARNDUFF	1069	No	No
CARON	125	No	No
CARONPORT	1147	No	No
CARROT RIVER	1032	No	No
CEDAR VILLA ESTATES	129	No	No
CENTRAL BUTTE	521	No	No
CEYLON	148	No	No
CHAMBERLAIN	114	No	No
CHAPLIN	314	No	No
CHELAN	57	No	No
CHOICELAND	417	✓	✓
CHURCHBRIDGE	815	No	No
CLAVET	339	No	No
CLEMENCEAU	7	No	No
CLIMAX	206	No	No
CODERRE	64	No	No
COLE BAY	153	No	No
COLEVILLE	323	No	No

PLACE	1996 Canada Census Population	In-Plant Study For Cost Estimate	Studied for Quality Management
COLGATE	40	No	No
COLONSAY	428	✓	No
CONGRESS	37	No	No
CONQUEST	195	No	No
CONSUL	107	No	No
CORNING	43	No	No
CORONACH	949	No	No
COURVAL	7	No	No
CRAIK	441	No	No
CRANE VALLEY	38	No	No
CRAVEN	278	No	No
CREELMAN	128	No	No
CREIGHTON	1713	No	No
CROOKED RIVER	78	No	No
CRYSTAL LAKE	34	No	No
CRYSTAL SPRINGS	24	No	No
CUDWORTH	752	No	No
CUMBERLAND HOUSE	836	No	No
CUPAR	592	✓	No
CUT KNIFE	585	No	No
DALMENY	1470	No	No
DANA	34	No	No
DAVIDSON	1105	No	No
DAVIN	48	No	No
DEBDEN	423	No	No
DELISLE	840	No	No
DELMAS	111	No	No
DEMAINE	37	No	No
DENARE BEACH	776	No	No
DENHOLM	63	No	No
DENZIL	194	✓	✓
DESCHARME LAKE	42	No	No
DILKE	85	No	No
DINSMORE	328	No	No
DISLEY	51	No	No
DODSLAND	241	No	No
DOMREMY	156	No	No
DORE LAKE	40	No	No
DORINTOSH	133	No	No
DRAKE	247	No	No
DRINKWATER	87	No	No
DUBUC	95	No	No
DUCK LAKE	667	✓	✓
DUFF	43	No	No
DUNDURN	476	No	No
DUVAL	98	No	No
DYSART	240	No	No
EARL GREY	268	No	No

PLACE	1996 Canada Census Population	In-Plant Study For Cost Estimate	Studied for Quality Management
EASTEND	616	No	No
EATONIA	469	No	No
EBENEZER	166	No	No
EDENWOLD	198	✓	✓
EDGELEY	29	No	No
ELBOW	295	✓	✓
ELDERSLEY	23	No	No
ELFROS	167	No	No
ELROSE	557	No	No
ELSTOW	93	No	No
EMERALD PARK	159	No	No
ENDEAVOUR	173	No	No
ENGLEFELD	223	No	No
ERNFOLD	51	No	No
ERWOOD	72	✓	✓
ESTERHAZY	2602	✓	No
ESTEVAN	10752	No	No
ESTON	1119	No	No
EVESHAM	40	No	No
EYEBROW	175	No	No
FAIRHOLME	29	No	No
FAIRLIGHT	56	No	No
FAIRY GLEN	32	No	No
FENWOOD	58	No	No
FERLAND	67	No	No
FILLMORE	286	No	No
FINDLATER	57	No	No
FLAXCOMBE	126	No	No
FLEMING	89	No	No
FOAM LAKE	1303	✓	✓
FORT QU'APPELLE	1997	No	No
FOSSTON	85	No	No
FOX VALLEY	359	No	No
FRANCIS	190	No	No
FRENCHMAN BUTTE	65	No	No
FROBISHER	165	✓	✓
FRONTIER	309	No	No
FULDA	34	No	No
GARRICK	30	✓	✓
GARSON LAKE	34	No	No
GERALD	164	No	No
GLADMAR	49	No	No
GLASLYN	374	No	No
GLEN EWEN	148	No	No
GLEN HARBOUR	40	No	No
GLENAVON	230	No	No
GLENSIDE	69	No	No
GLIDDEN	48	No	No

PLACE	1996 Canada Census Population	In-Plant Study For Cost Estimate	Studied for Quality Management
GOLDEN PRAIRIE	78	No	No
GOODEVE	71	No	No
GOODSOIL	278	No	No
GOVAN	316	No	No
GRAND COULEE	336	✓	No
GRAVELBOURG	1211	✓	No
GRAY	91	No	No
GRAYSON	223	No	No
GREEN LAKE	536	No	No
GREENSTREET	50	No	No
GRENFELL	1106	No	No
GRIFFIN	72	No	No
GRONLID	104	No	No
GUERNSEY	129	No	No
GULL LAKE	1078	✓	✓
HAFFORD	424	✓	✓
HAGEN	46	No	No
HAGUE	688	✓	✓
HALBRITE	111	No	No
HANDEL	42	No	No
HANLEY	491	No	No
HARRIS	245	No	No
HAWARDEN	81	No	No
HAZEL DELL	32	No	No
HAZLET	120	No	No
HENDON	30	No	No
HERBERT	855	No	No
HERSCHEL	44	No	No
HILLMOND	25	No	No
HITCHCOCK	99	No	No
HODGEVILLE	207	✓	✓
HOEY	50	No	No
HOLDFAST	216	No	No
HUBBARD	53	No	No
HUDSON BAY	1883	No	No
HUMBOLDT	5074	No	No
HYAS	119	No	No
ILE A LA CROSSE	1403	No	No
IMPERIAL	382	No	No
INDIAN HEAD	1833	No	No
INSINGER	17	No	No
INVERMAY	295	No	No
ITUNA	743	No	No
JANS BAY	199	No	No
JANSEN	167	No	No
JASMIN	6	No	No
JEDBURGH	13	No	No
KAMSACK	2264	No	No

PLACE	1996 Canada Census Population	In-Plant Study For Cost Estimate	Studied for Quality Management
KANNATA VALLEY	83	No	No
KAYVILLE	27	No	No
KEELER	21	No	No
KELLIHER	338	No	No
KELVINGTON	1046	No	No
KENASTON	323	No	No
KENDAL	98	No	No
KENOSEE LAKE	202	No	No
KERROBERT	1109	No	No
KETCHEN	15	No	No
KEYSTOWN	12	No	No
KHEDIVE	29	No	No
KILLALY	88	No	No
KINCAID	177	✓	No
KINDERSLEY	4679	No	No
KINISTINO	691	No	No
KIPLING	1004	No	No
KRONAU	189	No	No
KUROKI	97	No	No
KYLE	479	No	No
LA LOCHE	1966	No	No
LA RONGE	2964	No	No
LAC VERT	54	No	No
LAFLECHE	476	No	No
LAIRD	235	No	No
LAKE ALMA	40	No	No
LAKE LENORE	290	No	No
LAMPMAN	648	No	No
LANCER	99	No	No
LANDIS	189	No	No
LANG	189	No	No
LANGBANK	28	No	No
LANGENBURG	1119	No	No
LANGHAM	1104	No	No
LANIGAN	1368	No	No
LASHBURN	674	No	No
LEADER	983	No	No
LEASK	435	No	No
LEBRET	226	No	No
LEMBERG	353	No	No
LEOVILLE	359	No	No
LEROSS	82	No	No
LEROY	420	✓	No
LESLIE	34	No	No
LESTOCK	301	No	No
LIBERTY	101	✓	No
LIMERICK	165	No	No
LINTLAW	208	No	No

PLACE	1996 Canada Census Population	In-Plant Study For Cost Estimate	Studied for Quality Management
LIPTON	345	No	No
LIVELONG	79	No	No
LLOYDMINSTER SK & AB	18953	No	No
LONE ROCK	68	No	No
LOON LAKE	390	No	No
LOREBURN	150	No	No
LOVE	83	No	No
LUCKY LAKE	353	No	No
LUMSDEN	1530	No	No
LUSELAND	622	✓	✓
MACKLIN	1281	No	No
MACNUTT	95	✓	✓
MACOUN	148	✓	✓
MACRORIE	110	No	No
MAIDSTONE	962	✓	No
MAJOR	72	No	No
MAKWA	104	No	No
MANITOU BEACH	147	✓	No
MANKOTA	326	✓	✓
MANOR	347	No	No
MAPLE CREEK	2307	No	No
MARCELIN	182	No	No
MARCHWELL	87	No	No
MARENGO	61	✓	✓
MARGO	127	No	No
MARKINCH	72	No	No
MARQUIS	98	No	No
MARSDEN	263	No	No
MARSHALL	605	No	No
MARTENSVILLE	3477	No	No
MARYFIELD	363	No	No
MARYSBURG	20	No	No
MAYFAIR	64	No	No
MAYMONT	156	✓	✓
MAZENOD	33	No	No
MCLEAN	262	No	No
MCTAGGART	124	No	No
MEACHAM	79	No	No
MEADOW LAKE	4813	✓	✓
MEATH PARK	210	✓	✓
MEDSTEAD	162	No	No
MELFORT	5759	No	No
MELVILLE	4646	No	No
MEOTA	274	✓	✓
MEYRONNE	40	No	No
MICHEL VILLAGE	75	No	No
MIDALE	522	No	No
MIDDLE LAKE	268	No	No

PLACE	1996 Canada Census Population	In-Plant Study For Cost Estimate	Studied for Quality Management
MIKADO	50	✓	No
MILDEN	208	No	No
MILESTONE	540	No	No
MINTON	101	No	No
MISSINIEPIE	40	No	No
MISTATIM	114	No	No
MONTMARTRE	485	No	No
MOOSE JAW	32973	No	No
MOOSOMIN	2420	No	No
MORSE	284	No	No
MORTLACH	276	✓	✓
MOSSBANK	410	No	No
MOZART	57	✓	✓
MUENSTER	381	No	No
NAICAM	789	No	No
NEILBURG	345	No	No
NEUDORF	331	No	No
NIPAWIN	4318	No	No
NOKOMIS	469	No	No
NORQUAY	505	No	No
NORTH BATTLEFORD	14041	No	No
NORTH PORTAL	148	No	No
NUT MOUNTAIN	14	✓	✓
ODESSA	268	No	No
OGEMA	349	No	No
OKLA	26	No	No
ORMISTON	51	No	No
OSAGE	23	No	No
OSLER	618	No	No
OUTLOOK	2116	No	No
OXBOW	1163	✓	No
PADDOCKWOOD	187	✓	No
PALMER	29	No	No
PAMBRUN	88	No	No
PANGMAN	251	No	No
PARADISE HILL	466	No	No
PARKBEG	40	No	No
PARRY	28	No	No
PATHLOW	38	No	No
PATUANAK	89	No	No
PAYNTON	161	No	No
PEEBLES	24	No	No
PELICAN NARROWS	445	No	No
PELLY	331	No	No
PENNANT	135	No	No
PENSE	534	No	No
PENZANCE	46	No	No
PERDUE	403	No	No

PLACE	1996 Canada Census Population	In-Plant Study For Cost Estimate	Studied for Quality Management
PIAPOT	55	No	No
PIERCELAND	488	✓	✓
PILGER	106	No	No
PINEHOUSE LAKE	922	No	No
PLEASANTDALE	113	No	No
PLENTY	138	No	No
PLUNKETT	85	No	No
PONTEIX	544	No	No
PORCUPINE PLAIN	866	No	No
PRAIRIE RIVER	26	No	No
PREECEVILLE	1148	No	No
PRELATE	189	✓	No
PRIMATE	69	No	No
PRINCE ALBERT	34777	No	No
PRUD'HOMME	224	No	No
PUNNICHY	338	No	No
QU'APPELLE	632	No	No
QUILL LAKE	463	No	No
QUINTON	138	No	No
RABBIT LAKE	117	✓	✓
RADISSON	403	No	No
RADVILLE	823	No	No
RAMA	99	No	No
RAYMORE	667	✓	No
READLYN	5	No	No
REDVERS	965	✓	✓
REGINA	180400	No	No
REGINA BEACH	984	No	No
RHEIN	197	No	No
RICETON	91	No	No
RICHMOUND	203	No	No
RIDGEDALE	104	✓	✓
RIVERHURST	158	No	No
ROCANVILLE	875	No	No
ROCHE PERCEE	149	✓	✓
ROCKGLEN	481	No	No
ROSE VALLEY	406	No	No
ROSETOWN	2496	No	No
ROSTHERN	1564	No	No
ROULEAU	449	No	No
RUSH LAKE	71	No	No
SALTCOATS	531	No	No
SALVADOR	42	✓	✓
SANDY BAY	959	No	No
SARNIA BEACH	7	No	No
SASKATOON	193647	No	No
SCEPTRE	154	No	No

PLACE	1996 Canada Census Population	In-Plant Study For Cost Estimate	Studied for Quality Management
SCOTT	118	No	No
SCOUT LAKE	15	No	No
SEDLEY	305	No	No
SEMANS	315	No	No
SENLAC	78	No	No
SHAMROCK	30	No	No
SHAUNAVON	1857	✓	✓
SHEHO	181	No	No
SHELLBROOK	1234	✓	No
SILTON	86	No	No
SIMPSON	208	No	No
SINTALUTA	189	No	No
SLED LAKE	93	No	No
SMEATON	192	No	No
SMILEY	68	No	No
SNOWDEN	36	No	No
SOUTHEND	340	No	No
SOUTHEY	679	No	No
SOVEREIGN	58	✓	✓
SPALDING	281	No	No
SPEERS	84	No	No
SPIRITWOOD	924	No	No
SPRING VALLEY	16	No	No
SPRINGSIDE	542	No	No
SPRUCE LAKE	73	No	No
SPY HILL	264	No	No
ST BENEDICT	119	No	No
ST BRIEUX	507	No	No
ST GEORGES HILL	85	No	No
ST GREGOR	128	No	No
ST ISIDORE-DE-BELLEVUE	97	No	No
ST LOUIS	437	No	No
ST VICTOR	47	No	No
ST WALBURG	685	No	No
STANLEY MISSION	190	No	No
STAR CITY	492	No	No
STENEN	100	No	No
STEWART VALLEY	101	No	No
STOCKHOLM	356	✓	✓
STONY BEACH	25	No	No
STONY RAPIDS	233	No	No
STORTHOAKS	119	No	No
STOUGHTON	729	No	No
STRASBOURG	760	No	No
STRONGFIELD	49	No	No
STURGIS	684	No	No
SWAN PLAIN	21	No	No
SWIFT CURRENT	14890	No	No

PLACE	1996 Canada Census Population	In-Plant Study For Cost Estimate	Studied for Quality Management
SYLVANIA	67	No	No
TADMORE	40	No	No
TANTALLON	137	✓	✓
THEODORE	434	No	No
TIMBER BAY	101	No	No
TISDALE	2966	No	No
TOGO	138	No	No
TOMPKINS	201	No	No
TORQUAY	285	No	No
TRAMPING LAKE	118	No	No
TROSSACHS	35	No	No
TUFFNELL	26	No	No
TURNOR LAKE	198	No	No
TURTLEFORD	467	No	No
TUXFORD	102	No	No
UNITY	2200	No	No
URANIUM CITY	173	No	No
VALPARAISO	18	No	No
VANGUARD	207	No	No
VANSCOY	316	✓	No
VAWN	49	No	No
VEREGIN	90	No	No
VERWOOD	12	No	No
VIBANK	363	No	No
VICEROY	64	No	No
VISCOUNT	295	No	No
VONDA	289	No	No
WADENA	1477	No	No
WAKAW	869	No	No
WALDECK	335	No	No
WALDHEIM	841	No	No
WAPELLA	387	No	No
WARMAN	2839	No	No
WASECA	153	No	No
WATROUS	1860	✓	No
WATSON	837	No	No
WAWOTA	620	✓	✓
WEBB	42	No	No
WEEKES	84	✓	✓
WEIRDALE	63	✓	✓
WELDON	552	No	No
WELWYN	146	No	No
WEYAKWIN	171	No	No
WEYBURN	9723	No	No
WHITE BEAR	27	No	No
WHITE CITY	905	No	No
WHITE FOX	402	No	No
WHITEWOOD	985	No	No

PLACE	1996 Canada Census Population	In-Plant Study For Cost Estimate	Studied for Quality Management
WILCOX	311	No	No
WILKIE	1364	No	No
WILLOW BUNCH	431	No	No
WILLOWBROOK	41	No	No
WINDTHORST	239	No	No
WISETON	125	No	No
WISHART	153	No	No
WOLLASTON LAKE	229	No	No
WOLSELEY	821	No	No
WOOD MOUNTAIN	31	No	No
WOODROW	17	No	No
WROXTON	49	No	No
WYNYARD	1954	No	No
YARBO	127	No	No
YELLOW CREEK	73	No	No
YELLOW GRASS	488	No	No
YORKTON	15154	No	No
YOUNG	320	No	No
ZEALANDIA	117	No	No
ZELMA	43	No	No
ZENON PARK	259	No	No

Appendix B - Mail Survey to Communities



Sask Water

Our Water . . . Our Future

Waterworks Survey

Please read the following instructions and survey then answer the questions. Some questions are technical and may require your operator or waterworks designer to complete.

Circle the most appropriate answer, fill in the blanks or mark "NA" for questions that are not applicable.

Mark "Unknown" where an answer is not clear or the technical data is not available.

Add extra relevant information on the blank lines.

If your community has no water supply and treatment system or is supplied water from a regional treated supply system write this on the survey and complete the relevant questions.

Contact Sask Water at (306) 694-3848 for any clarifications.

Mail the completed survey to Sask Water using the enclosed return envelope.

Community Name: _____

General

1. We have a copy of engineered plans for:

a) the raw water supply system	Yes	No
b) the water treatment system	Yes	No
c) the treated water storage system	Yes	No
d) the water mains system	Yes	No
2. Our last comprehensive professional review of our entire water system was in _____ (year).
3. We are planning to undertake a comprehensive professional review: Yes _____ (year) No
4. Our last major water system upgrade was in _____ (year).
5. We are planning to construct a major water supply, water treatment or water storage system in the next _____ (years).
6. In the last five years we have rationed water: Yes No
7. We have a bylaw or rate structure that restricts water use (eg. for lawn watering): Yes No
8. All our services/houses have water meters: Yes No
9. In 2000, we spent \$ _____ for operation and maintenance of our drinking water supply, treatment and distribution systems.

Raw Water Supply

The following questions refer to the components of the raw water supply system, including surface water intakes, wells, pumping facilities and pipelines.

10. Our raw water is (please circle the most appropriate answer):
 - a) surface water only
 - b) groundwater only
 - c) a combination of groundwater and surface water.
11. If a groundwater supply is used how many wells do you have for: Normal use _____, Standby _____
12. The depth of our shallowest active or standby groundwater well is _____ feet.
13. Please indicate the number of raw water supply pipelines from the water source to the water treatment plant: _____.
14. The average age of our raw water pipelines is _____ years. (ex. 10 yrs, 20 yrs, etc).
15. The oldest raw supply pipeline that we still use is _____ years old.
16. We swab or flush our raw water pipelines:
 - a) routinely every _____ years
 - b) only when cleaning is needed
 - c) never
17. We inspect and service our surface intake or wells:
 - a) routinely every _____ years
 - b) only when a problem develops
 - c) never
18. Watershed protection studies evaluate methods a community can use to protect drinking water supplies by minimizing potential contamination of surface water reservoirs and groundwater sources. We have completed a professional watershed protection report for our drinking water supply:
 - a) in the last 5 years
 - b) prior to 1996
 - c) we have never performed any such study
19. In the last year our raw supply system has failed _____ times. ("Failure" is any loss of needed raw water supply for any reason including equipment malfunction, pipeline breaks, well problems, pump or valve failure, electrical problems, flood, etc).

20. The average condition of our raw water pipelines is: a) good
b) fair
c) poor
d) very poor
e) unknown
21. Since 1985 our surface water reservoir had inadequate raw water volumes in _____ (years).
22. The capacity of our raw water system (intakes, wells, pumps, pipelines):
a) needs to be increased now to meet our current needs
b) is expected to be adequate for _____ years
c) needs more study to determine adequacy
23. Our greatest concern about our raw water supply system is (eg. quality, quantity of supply, other)

_____.
24. We have a cost estimate for upgrading our raw water supply system. The upgrade estimate was prepared in _____ (year) and included (please briefly describe the work) _____

_____.
25. The cost for the above work was \$ _____ and the cost estimate was prepared by _____

_____.

Water Treatment Plant

The following questions refer to components of the water treatment system, including treatment equipment and building structures.

26. Circle the types of treatment plant(s) you have:
a) only groundwater plant(s) with a total maximum treatment capacity of _____ igpm or _____ imperial gallons per day.
b) only surface water plant(s) with a total maximum treatment capacity of _____ igpm or _____ imperial gallons per day.
c) both surface and groundwater plant(s) with a combined maximum treatment capacity of _____ igpm or _____ imperial gallons per day.

27. The age of the original treatment plant building structure is _____ (years). The age of the newest treatment plant building structure(s) is _____ (years).
28. The average condition of the plant building structure is:
 - a) good
 - b) fair
 - c) poor
 - d) very poor
 - e) unknown
29. We provide consumers with groundwater but do not filter the water: Yes No
30. A settling tank is a chamber or vessel used to settle and remove larger particles from the raw water. Chemicals, such as alum or polyaluminum chloride are called "coagulants" help particle settling. The settling tank is located before filters.
 - a) we treat surface water by filtration but have no settling tank Yes No
 - b) we add a coagulant or other chemical to assist in removing particles Yes No
31. We use chlorine or a chlorine-related drinking water disinfectant: Yes No
32. We do not add any disinfectant to the drinking water provided to consumers: True False
33. We measure the chlorine residual at the plant daily: Yes No
34. Our currently-used liquid chlorine feed pump is _____ years old.
35. We use a water disinfectant that is not chlorine-related (eg. ultra-violet, ozone, other)
_____.
36. Our disinfection system:
 - a) has never failed to add disinfectant to the water when needed
 - b) has failed once in the last year
 - c) has failed more than once in the last year
37. We have a complete set of backup disinfection equipment (chemical pumps, etc): Yes No
38. We have written and implemented a plan laying out what our actions will be in the event of harmful bacteria being detected in the treated water: Yes No
39. We have an Operations Manual for our water treatment plant(s): Yes No
40. We perform maintenance at the treatment plant:
 - a) routinely before problems occur
 - b) only when a problem develops

41. Our highest trained water treatment plant operator has a SERM Certification level of:
- a) WT1
 - b) WT2
 - c) WT3
 - d) WT4
 - e) uncertified
42. The plant is checked daily: Yes No
43. We keep daily records of operations: Yes No
- Please submit a copy of the water treatment plant record form for either December 2000, or January 2001. This record typically shows in-plant water quality tests, chlorine tests, meter readings and other operating information.*
44. Our treatment plant was last inspected by a regulatory professional (SERM, Public Health or other) in: _____ (year) _____ (Agency).
45. We obtain expert advice from on-staff or external Professional Engineers whenever we have a major or serious operational problem: Yes No
46. We obtain expert advice from on-staff or external Professional Engineers whenever a *treatment equipment upgrade* is done: Yes No
47. Our treatment capacity: a) needs to be increased now to meet our current needs
b) is expected to be adequate for _____ years
c) needs more study to determine adequacy
48. Our greatest concern about our water treatment plant is _____

_____.
49. We have a cost estimate for upgrading our water treatment plant. The upgrade estimate was prepared in _____ (year) and included (please briefly describe the work) _____

_____.
50. The cost for the above work was \$ _____ and the cost estimate was prepared by _____

_____.

Treated Water Reservoir and Distribution System

The following questions refer to components of the treated water reservoir, distribution pumping system and water mains.

51. Our treated water storage is: a) underground reservoir
 b) elevated tanks
 c) both
52. The combined volume of all treated water storage reservoirs is _____ igal.
53. The age of the original treated water reservoir is _____ (years).
54. The age of the newest treated water reservoir is _____ (years).
55. The average condition of the treated water reservoir is: a) good
 b) fair
 c) poor
 d) very poor
 e) unknown
56. We clean our treated water reservoir: a) routinely every _____ years
 b) only when cleaning is needed
 c) never
57. Our last treated water reservoir cleaning occurred in _____ (year).
58. In the last year our distribution pump system has failed _____ times. ("Failure" is any loss of needed distribution pumping for any reason including equipment malfunction, pump or valve failure, electrical problems, control system problems, etc).
59. The average condition of our distribution pumps is: a) good
 b) fair
 c) poor
 d) very poor
 e) unknown
60. We inspect and service our distribution pumps: a) routinely every _____ years
 b) only when a problem develops
 c) never

61. We have only one distribution pump: Yes No
62. We have: a) a standby or fire pump and engine.
b) standby power generation.
63. Our distribution pump capacity: a) needs to be increased now to meet our current needs
b) is expected to be adequate for _____ years
c) needs more study to determine adequacy
64. We swab or flush our water mains: a) routinely every _____ years
b) only when cleaning is needed
c) never
65. Our last water main flushing occurred in _____ (year).
66. The average age of our distribution mains is _____ (years).
67. In the last two years we had an average of _____ water main breaks per year.
68. Our water mains are mainly:
a) plastic (PVC, polyethylene, etc.)
b) asbestos-cement
c) ductile iron
d) cast iron
e) other _____
69. The average condition of our distribution piping is :
a) good
b) fair
c) poor
d) very poor
d) unknown
70. Our greatest concern about our reservoir and distribution system is _____

_____.
71. We have a cost estimate for upgrading our treated water storage or distribution system. The upgrade estimate was prepared in _____ (year) and included (please briefly describe the work) _____

_____.

72. The cost for the above work was \$ _____ and the cost estimate was prepared by _____

73. Costs for upgrades to your distribution system are recovered through:

- a) a frontage charge
- b) water rates
- c) from a reserve fund

74. This survey was completed by the following persons:

Date: _____

Name

Title

Additional Comments:

~ THANK YOU ~

Appendix C - Drinking Water Health Protection Record

Sask Water Water Quality Communities

Sask Water Community Name EMERALD PARK
 SERM Esqudat Community Name & Id EMERALD PARK
 Community Type Unincorporated Place
 Total Protection 1,800.00

Community

1996 Canada Census Population 159
 Water Type Raw
 Year of Peak Consumption 2000
 2000 Annual Consumption 137,794.00 m3 30.32 mig
 2000 Peak Day Consumption 1,390.00 m3 305,800.00 igal
 2000 Peak Day Production 16.09 lps 212.00 igpm
 2000 365 Day Per Capita Consumption 2,374.33 lcd
 2000 Estimated Peak Day Treated Water Demand 15.18 lps 200.00 igpm
 2001 Estimated Peak Day Treated Water Demand 15.26 lps 202.00 igpm
 2021 Estimated Peak Day Treated Water Demand 16.86 lps 223.00 igpm

Protection Barrier Parameter

Plant Condition	Protection Indicator	PB	IB	PBxIB
Plant Condition meets SERM Minimum Treatment Standards	Yes	0.90	250	225.00
Water Source				
Sask Water Surface Water	No	0.40	125	50.00
Sask Water Ground Water	No			
SERM Surface Water	No			
SERM Ground Water	Yes			
Well Type	Unknown			
Well Depth (feet)	0.00			
Operation				
Treatment Operator Training - Actual	Level 1			
Treatment Operator Training - Required	Level 1		150	142.50
Distribution Operator Training - Actual	Level 1			
Distribution Operator Training - Required	Level 1		50	47.50
Sum of Operation PBxIB				190.00

Protection Barrier Parameter	Protection Indicator	PB	IB	PBxIB
Treated Water Quality				
Advisory				
Days on Drinking Water Advisory	0.95	30	28.50	
Occurrences of Drinking Water Advisory	0	0.99	30	19.80
Days on Drinking Water	0	0.99	50	49.50
Occurrences of Drinking Water	0	0.99	30	29.70
Advisory Continued ?	No	0.99	10	9.90
E Coli Advisory	0	0.99	50	49.50
Acute Indicators				
Fecal Coliform (Max)	0.00	0.99	125	123.75
E Coli (Max)	0.00	0.99	250	247.50
Bacti Failure	<25%	0.90	375	337.50
Nitrate (Max)	1.00	0.95	100	95.00
Turbidity (Max)	0.98	0.99	15	14.85
Turbidity (Avg)	0.98	0.95	50	47.50
Non-Acute Indicators				
Nitrate (Avg)	1.00	0.99	30	29.70
Lead (Max)	0.00	0.99	20	19.80
Lead (Avg)	0.00	0.99	30	29.70
Arsenic (Max)	0.50	0.99	20	19.80
Arsenic (Avg)	0.50	0.99	30	29.70
Boron (Max)	0.14	0.99	5	4.95
Boron (Avg)	0.14	0.99	10	9.90
Selenium (Max)	0.00	0.99	5	4.95
Selenium (Avg)	0.00	0.99	10	9.90
Fluoride (Max)	0.38	0.99	5	4.95
Fluoride (Avg)	0.36	0.99	10	9.90
Protection Barrier Parameter	Protection Indicator	PB	IB	PBxIB
Non-Acute Indicators(continued)				
Trihalomethane (Max)	0.00	0.99	20	19.80
Trihalomethane (Avg)	0.00	0.99	30	29.70
Uranium (Max)	4.40	0.99	5	4.95
Uranium (Avg)	4.40	0.99	10	9.90
Mercury (Max)	0.00	0.99	10	9.90
Mercury (Avg)	0.00	0.99	20	19.80
Aesthetic Indicators				
Color (Max)	0.00			
Color (Avg)	0.00			
Alkalinity (Max)	314.00			
Alkalinity (Avg)	314.00			
Chloride (Max)	4.00			
Chloride (Avg)	4.00			
Hardness (Max)	399.00			
Hardness (Avg)	399.00			
Iron (Max)	0.03	0.99	5	4.95
Iron (Avg)	0.03	0.99	10	9.90
Manganese (Max)	0.05	0.99	5	4.95
Manganese (Avg)	0.05	0.99	10	9.90
Sodium (Max)	36.00	0.99	5	4.95
Sodium (Avg)	36.00	0.99	10	9.90
Sulphate (Max)	171.00			
Sulphate (Avg)	171.00			
Total Dissolved Solids (Max)	726.00			
Total Dissolved Solids (Avg)	726.00			
pH (Max)	7.30			
pH (Avg)	7.30			
Sum of Treated Water Quality PBxIB				1,335.15

Appendix D - On-Site Consultant Evaluation Survey

**APPENDIX A
MUNICIPAL WATERWORKS INFORMATION**

Page 1 of 8

COMMUNITY: _____ Site Visit Date: _____

Population: _____

Persons Interviewed:

Name _____ Position _____

Drinking Water Provided to:

- Community only? Yes ☐, No ☐
- Rural Users (truck haul)? Yes ☐, No ☐
- Other Users (pipeline)? Yes ☐, No ☐

Describe: _____

Water Demands

- Average day _____
- Peak day _____

Water Use Control

- Restrictions required? Yes ☐, Yes, infrequently ☐, No ☐
- Metering - all services Yes ☐, No ☐
 - reading frequency: monthly ☐, 2 month ☐, 3 month ☐, Other _____
- Rate structure: base + increasing increment ☐, uniform ☐
base + declining increment ☐, Other _____

WATER SUPPLY

• Groundwater

- Total wells available: _____
- No. of wells used @ average demand _____; @ peak demand _____
- Range of total depths: _____ m.
- Wells protection; describe _____

• Surface Water

- Water course/water body _____
- Local other uses _____
- Off-stream storage? Yes ☐, No ☐, capacity _____ m³.
Normal fill period(s) _____

• Supply Problems?

- Quantity - Yes ☐, No ☐, if yes, describe: _____
- Quality - Yes ☐, No ☐, if yes, describe: _____

• Delivery Capacity: _____ L/s

• Supply Pipeline(s): Year installed _____
Diameter _____
Pipe material _____
Known Condition _____

WATER TREATMENT FACILITY

- Year Constructed: _____ Year last major expansion _____
- Rated Capacity: _____ L/s based on _____
- Highest operating capacity in last three years: _____ L/s.

Note: Metric units to be used; please convert as encountered.

Community

• Treatment Train

<u>Unit Process</u>	<u>Present</u>	<u>Comments</u>
• Pretreatment		
- Chemical Oxidation		
- KMnO ₄	☐	Dosage Control - Manual ☐ Other _____
- Oxidation	☐	Dosage Control - Manual ☐ Other _____
- Aeration	☐	Type: _____
- Other	☐	Describe: _____
• Coagulation	☐	Coagulants used: _____ Dosage Control - Manual ☐ Other _____
• Flocculation	☐	Flocculants used: _____ Dosage Control - Manual ☐ Other _____ Flocculation Type: _____ Capacity: _____ Condition: _____
• Sedimentation	☐	Type: _____ Capacity: _____ Condition: _____
• Filtration	☐	Controls - Manual ☐ , Automatic ☐
- Pressure	☐	Units/Sizes: _____ Total Capacity: _____ Media: _____ Filtration Rate: _____ Condition: _____
- Gravity	☐	Units/Sizes: _____ Total Capacity: _____ Media: _____ Filtration Rate: _____ Condition: _____
• GAC Adsorption	☐	Units/Sizes: _____ Type: _____
• Cl ₂ Disinfection	☐	Dosage Control - Manual ☐ Other _____ Gas ☐ , Solution ☐
• Fluoridation	☐	Dosage Control - Manual ☐ Other _____ Chemical Used: _____
• Other _____	☐	Dosage Control - Manual ☐ Other _____ Describe _____

• Wastewater (backwash/blowdown)

• Describe discharge practices/destination: _____

• Physical Plant

- Building: Structural Materials _____
General Condition _____
Space Constraints? Yes ☐, No ☐
- Electrical/Systems: General Condition _____

Community

- Mechanical (HVAC) Systems:
 - General Condition _____
 - Piping/Valves, etc.,
 - General Condition _____
 - Truck Fill Facilities - Yes ☐, No ☐
 - Backflow Prevention - Yes ☐, No ☐, If yes, type _____
 - Laboratory/Testing Area - Available - Yes ☐, No ☐
 - Suitability _____
 - Metering:

<u>Operating Meter Sites</u>	<u>Totalizing (units)</u>	<u>Flow Rate Only (units)</u>
Supply (Source)	☐ _____	☐ _____
Raw (at WTP)	☐ _____	☐ _____
Backwash	☐ _____	☐ _____
Distribution	☐ _____	☐ _____
Truckfill	☐ _____	☐ _____
- Inoperative meters? - Describe _____

TREATED WATER PUMPING

- Distribution pumps, number _____
- Dedicated backwash pump Yes ☐, No ☐
- Estimated peak hourly pumping capacity: _____
- Fire pump(s): Yes ☐, No ☐
- Emergency capability:

Engine driven pump	Yes ☐ , No ☐
Gen set	Yes ☐ , No ☐

TREATED WATER STORAGE

- Type and capacity:

Elevated	Yes ☐ , No ☐ ; capacity _____ m ³ .
Underground	Yes ☐ , No ☐
	Number of compartments _____
	Capacities _____ m ³
	Flow routing _____
- Manway(s) protection; (curbing/covers) _____

WATER DISTRIBUTION

- Year first installed: _____
- Pipe type(s)(material): _____
- Range of mains pipe size (diameters): _____
- Mains replacements? Yes ☐, No ☐
- Freezing problems? Yes ☐, No ☐ , Bleeders used? Yes ☐, No ☐

OPERATIONS & MAINTENANCE

• Operating Personnel

- Water Treatment: No. of primary operators _____, backup _____.
- Water Distribution: Responsible charge operators _____.
- Operator attendance (water treatment) Same personnel as water treatment? Yes ☐, No ☐
Typical: _____ days/week
_____ hours/day
- Operator training: External courses - encouraged Yes ☐, No ☐
Course and year last attended _____
- Certification level (most senior operator) - Treatment WT1 ☐ WT2 ☐ WT3 ☐ WT4 ☐
Distribution WD1 ☐ WD2 ☐ WD3 ☐ WD4 ☐

• Testing and Records

- Quality testing equipment available (check applicable)

Chlorine residual	☐	Iron	☐	pH	☐
Turbidity	☐	Manganese	☐	Alkalinity	☐
Colour	☐	Fluoride	☐	Hardness	☐
Other ☐	describe _____				

- Continuous (in-line) monitors? (check applicable)

Turbidity	☐	Chlorine residual	☐	pH	☐
Other ☐	describe _____				

- Reagents/pillows, etc., supply maintenance/replacement

Typical purchase practice _____

- Equipment calibration practices - None ☐, Routine ☐ Describe _____

- Adequate test bench/cupboards? Yes ☐, No ☐
sink, washing facilities? Yes ☐, No ☐

- Frequency of testing (note time period)

<u>Test</u>	<u>Raw Water</u>	<u>Plant Treated Water</u>	<u>Distribution System</u>
<u>On-site</u>			
Chlorine Residual(T)	_____	_____	_____
Chlorine Residual (F)	_____	_____	_____
Turbidity	_____	_____	_____
Colour	_____	_____	_____
Iron	_____	_____	_____
Manganese	_____	_____	_____
Fluoride	_____	_____	_____
pH	_____	_____	_____
Alkalinity	_____	_____	_____
Hardness	_____	_____	_____
Other:	_____	_____	_____

Community

Laboratory

Bacteria (Coliform) _____

Nitrate _____

Fluoride _____

Trihalomethanes _____

General chemical
(inorganic) _____Heavy metals/
trace substances _____

Particle counts _____

Other: _____

- System bacteriological samples collection by: water treatment operator ☐,
Other ☐, identify _____

• Records Maintenance

<u>Item</u>	<u>Recorded</u>	<u>Frequency (note time period as applicable)</u>
Raw water quantity	☐	_____
Treated water quantity	☐	_____
Treated water rate	☐	_____
Backwash rate/duration	☐	_____
Truckfill quantity	☐	_____
System pressure	☐	_____
Filter Pressures/ (head loss)	☐	_____
Site quality testing	☐	_____
Off-site (laboratory testing)	☐	_____
Pump(s) operating hours	☐	_____
Chemical - solution strengths	☐	_____
- dosages (feeder settings)	☐	_____
- daily uses	☐	_____
- calculated dosages	☐	_____
Physical observations (odour, colour, clarity)		
- raw	☐	_____
- clarifier/filter influent	☐	_____
- filter backwash	☐	_____
- filter effluent	☐	_____
- reservoir (clearwell)	☐	_____
Process changes	☐	_____
Filter media inspections	☐	_____
Repairs, replacements	☐	_____
Cleaning (reservoir, etc.)	☐	_____
Malfunctions (equipment)	☐	_____
Other: _____	☐	_____
_____	☐	_____
_____	☐	_____

- Records/Data Review

<u>Item</u>	<u>Review By</u>		<u>Frequency/follow-up protocol</u>
	<u>Operator</u>	<u>Other (identify)</u>	
Chlorine residuals	☐	☐	_____
Fluoride concentration	☐	☐	_____
Bacteriological quality	☐	☐	_____
Bacti sample Submission	☐	☐	_____
Turbidity	☐	☐	_____
Other analyses	☐	☐	_____
Water use trends	☐	☐	_____

- Chemical Feeding

- Disinfectant feeder
 - spare available? Yes ☐, No ☐
 - spare parts on hand? Yes ☐, No ☐
- Other feeders
 - spare available? Yes ☐, No ☐
 - spare parts on hand? Yes ☐, No ☐
- Chemical inventory -

ChemicalSupply Maintained (weeks)

Chlorine
Coagulant
Flocculant
Fluoride
Other: _____

- Dosage adjustments made? Yes ☐, No ☐
If yes, describe chemicals and typical frequency

- Bench testing equipment (e.g., jar stirrers) available? Yes ☐, No ☐
If yes, frequency of use _____

- Safety equipment: gloves, apron ☐, goggles ☐, eye wash ☐

- Physical Maintenance/Repairs

- Preventative maintenance program used? Yes ☐, No ☐
Documented? Yes ☐, No ☐
- Testing/Calibrations

Meters Yes ☐, No ☐
Valves Yes ☐, No ☐
Pumps Yes ☐, No ☐
Feeders Yes ☐, No ☐
Other Describe _____

- Treated water storage cleaning - frequency _____
- Water distribution system
 - flushing frequency _____
 - swabbing frequency _____
 - repairs disinfection practice _____
- Structural inspections, Yes ☐, No ☐, If yes, frequency _____
- Electrical, controls inspections Yes ☐, No ☐, If yes, frequency _____
- Painting/coating

	<u>Frequency</u>
Piping	_____
Vessels	_____
Building	_____

MISCELLANEOUS

- Cross connection control program in place, Yes ☐, No ☐
 - Community regulated/inspected, Yes ☐, No ☐
 - Reliance on provincial regulations/inspection Yes ☐, No ☐
 - Waterworks external audits
 - Employed? Yes ☐, No ☐, If yes, frequency _____
 - If not, reason: cost ☐, no need ☐, unaware ☐
 - Crisis action plans developed:
 - Quality contamination? Yes ☐, No ☐
 - Water supply problem? Yes ☐, No ☐
 - Public notification process, describe _____
 - Budget Process
 - Routine O/M - submitted by _____
 - Major replacements, capital works - submitted by _____
 - Emergency funds available? Yes ☐, No ☐
 - Water use rate reviews
Frequency _____
-

SUMMARY - CONCEPTUAL IMPROVEMENTS/COST ESTIMATES

Component/Item	Brief Description Conceptual Improvement	Conceptual Cost Estimates (\$)	
		Present Capacity	Projected Capacity
Water Supply			
• Source augmentation			
• Delivery system			
Water Treatment			
• Process			
• Physical Plant			
Treated Water Storage			
Water Distribution			

Submitted by: _____

Date: _____

Provide any additional observations or comments and attached page(s).

Appendix E - Quality Management Community Summary

Table 1 (1 of 2)
QA/QCSUMMARY
Groundwater Supply Facilities

Population Range	<100	101-250	251-500	501-1000	1001-10000
No. of Communities	8	9	4	6	2
Site Testing and Records					
<i>Testing Equipment Available (Yes)</i>					
Chlorine Residual	8	9	4	6	2
Turbidity	0	0	1	3	0
Colour	0	0	1	4	0
Iron	3	6	4	5	1
Manganese	1	2	2	5	1
Fluoride	0	0	1	3	0
pH	0	1	0	2	1
Alkalinity	0	0	0	2	0
Hardness	1	0	0	2	1
Other	0	0	0	0	0
<i>Continuous Monitors (Yes)</i>					
Turbidity	0	0	0	0	0
Chlorine Residual	0	0	0	0	1
pH	0	0	0	0	0
Particle Counters	0	0	0	0	0
Other	0	0	0	0	0
<i>Equipment Calibration (Yes)</i>	0	2	0	3	1
<i>Adequate Testing Bench/Sink (Yes)</i>	2	5	3	3	2
<i>Frequency of Testing (PTW) (No per week)?</i>					
Chlorine Residual T	2.5-7	1-7	5-7	1-7	14
Chlorine Residual F	4-7	2-7	5-7	7	14
Turbidity	-	-	-	0-7	-
Colour	-	-	-	0-7	-
Iron	0.5-7	1-7	7	0-7	7
Manganese	0.25	-	7	0-7	7
Fluoride	-	-	7	0-7	-
pH	-	-	-	0-7	7
Alkalinity	-	-	-	-	-
Hardness	-	-	-	1/6wk-7	-
Other	-	-	-	-	7
<i>Records Maintenance (Yes)</i>	-	-	-	-	-
Raw Water Quantity	6	9	3	6	2
Treated Water Quantity	2	2	3	4	1
Treated Water Rate	0	0	0	2	0
Backwash Rate/Duration	0	1	0	3	1
Truckfill Quantity	0	0	1	2	0
System Pressure	1	0	0	3	0
Filter Pressures (Head loss)	0	0	1	1	0
Site Quality Testing	1	3	3	5	2
Off-site (laboratory testing)	0	2	2	4	2
Pump(s) Operating Hours	0	0	0	1	2
Chemical					
Solution Strengths	0	1	1	3	1
Dosages (Feeder Settings)	0	0	0	5	2
Daily Uses	2	4	1	4	1
Calculated Dosages	2	0	0	0	0
Physical Observations (odour, colour, clarity)					
Raw	1	0	0	1	1
Clarifier/Filter Influent	0	0	0	0	1
Filter Backwash	0	1	1	0	0
Filter Effluent	0	0	0	1	1
Reservoir (cleanwell)	0	1	0	3	1
Process Changes	0	0	0	2	1
Filter Media Inspections	1	0	0	3	1
Repairs, Replacements	2	3	1	4	2
Cleaning (reservoir, etc.)	2	1	1	4	1
Malfunctions (equipment)	0	1	0	3	2
Other	0	0	0	0	0
<i>External Laboratory Testing (Yes)</i>					
Plant					
Bacteria (Coliform)	2	2	2	2	0
Nitrate	0	0	0	0	0
Fluoride	0	0	0	1	0
Trihalomethanes	0	0	0	0	0
General Chemical (inorganic)	2	3	1	0	0
Heavy Metals/Trace Substances	1	1	1	0	0
Particle Counts	0	0	0	0	0
Other	0	1	0	0	0
Distribution System					
Bacteria (Coliform)	5	6	3	6	1
Nitrate	0	0	0	5	1
Fluoride	0	0	1	5	0
Trihalomethanes	0	0	0	0	0
General Chemical (inorganic)	0	0	1	5	1
Heavy Metals/Trace Substances	0	0	1	2	1
Particle Counts	0	0	0	0	0
Other	0	0	0	0	0

Table 1 (2 of 2)
QA/QCSUMMARY
Groundwater Supply Facilities

Population Range	<100	101-250	251-500	501-1000	1001-10000
No. of Communities	8	9	4	6	2
Records Review					
Chlorine Residuals	Op. SERM	Op	Op. SERM	Op. SERM. Utility	Op. Sup't
Fluoride Concentrations	-	-	Op. SERM	Op. SERM. Utility	-
Bacteriological Quantity	Op. SERM	Op, Admin, Council, SERM, Town officials	Op. Admin, SERM	Op. SERM, Utility	Sup't
Bactl Sample Submission	Op. SERM	Op, SERM	Op. Admin, SERM	Op. Utility	Sup't
Turbidity	-	-	SERM	Op. SERM, Utility	-
Treatment (Yes)					
Coagulant Always Used	0	0	0	1	0
Coagulant Control (Manual)	0	0	0	1	0
Chlorine Control (Manual)	6	6	2	4	2
Dosage Adjustments Made	7	6	4	6	1
Bench Testing Equipment (jar stirrers)	0	0	0	0	0
Disinfectant Feeder					
Spare	1	4	3	5	0
Parts	2	5	3	5	2
Other Feeder					
Spare	0	2	3	3	0
Parts	1	2	2	3	1
Feeders Calibrated	0	2	0	1	0
Chemical Supplies (> 2 weeks)	7	8	4	5	2
Metering (Yes)					
Raw Water	7	8	3	6	1
Backwash	0	1	1	4	0
To Distribution	0	0	1	4	0
Calibration	0	0	0	1	0
Preventative Maintenance (Yes)					
Program in Place	1	5	3	1	2
Pump Testing	0	1	0	1	1
Valve Testing	0	2	0	1	0
Protection (Yes)					
Storage Reservoir Manways - Satisfactory	7	4	3	3	1
Truckfill - BFP	1	2	2	4	0
Cross-Connection Control Program	0	0	1	2	0
Cleaning (Yes)					
Treated Water Storage					
Annual	2	2	0	0	1
1-5 Years	5	4	1	4	1
>5 Years	1	1	1	1	0
Distribution System Flushing					
Annual or Less	2	7	4	2	2
1-5 Years	1	1	0	1	0
>5 Years	0	0	0	0	0
Distribution System Swabbing					
1-5 Years	0	1	1	1	2
5-10 Years	0	0	0	0	0
Never	8	6	3	1	0
Operators					
No. of Primary Operators	1	1	1	1-2	1-2
Backup (Yes)	7	7	4	5	1
Attendance					
Days Per Week					
Range	2-7d	1/mon - 7	5-7 d	5-7	7
Hours Per Day					
Range	0.25-1.5	0.5-4	0.5-2	3*	3-4
Average	0.75	1.11	0.94	1.5*	3.5
Certified (Yes)	2	3	2	5	2
External Audits (Yes)	2	1	0	1	1

*) for one site surveyed community only

Table 2 (1 of 2)
QA/QC SUMMARY
Surface Supply Facilities

Population Range	<100	101-250	251-500	501-1000	1001-10000
No. of Communities	5	1	3	2	1
Site Testing and Records					
Testing Equipment Available (Yes)					
Chlorine Residual	4	1	3	2	1
Turbidity	1	0	1	0	1
Colour	0	0	0	1	1
Iron	0	0	1	1	1
Manganese	0	0	0	1	1
Fluoride	0	0	0	0	1
pH	0	0	1	1	1
Alkalinity	0	0	0	0	1
Hardness	0	0	1	0	1
Other	0	0	0	0	0
Continuous Monitors (Yes)					
Turbidity	0	0	0	0	0
Chlorine Residual	0	0	0	0	0
pH	0	0	0	0	0
Particle Counters	0	0	0	0	0
Other	0	0	0	0	0
Equipment Calibration (Yes)	0	0	0	0	1
Adequate Testing Bench/Sink (Yes)	2	0	2	1	1
Frequency of Testing (PTW) (No per week)?					
Chlorine Residual T	Monthly - 7 d	7	7	7	7
Chlorine Residual F	Monthly - 7 d	7	7	7	7
Turbidity	- to 7	-	- to 7	-	7
Colour	-	-	-	-	7
Iron	-	-	-	-	7
Manganese	-	-	-	-	7
Fluoride	-	-	-	-	-
pH	-	-	-	-	-
Alkalinity	-	-	-	-	-
Hardness	-	-	-	-	-
Other	-	-	-	-	-
Records Maintenance (Yes)					
Raw Water Quantity	3	0	3	2	0
Treated Water Quantity	0	1	1	1	1
Treated Water Rate	0	0	1	0	0
Backwash Rate/Duration	0	0	1	0	1
Truckfill Quantity	0	0	0	1	0
System Pressure	0	0	0	0	1
Filter Pressures (Head loss)	0	0	0	2	1
Site Quality Testing	4	1	3	2	1
Off-site (laboratory testing)	1	0	0	1	1
Pump(s) Operating Hours	0	0	0	0	0
Chemical					
Solution Strengths	1	0	0	0	0
Dosages (Feeder Settings)	0	0	1	0	1
Daily Uses	1	0	1	2	1
Calculated Dosages	0	0	0	0	0
Physical Observations (odour, colour, clarity)					
Raw	0	0	0	1	1
Clarifier/Filter Influent	0	0	0	1	0
Filter Backwash	0	0	0	0	0
Filter Effluent	0	0	0	0	0
Reservoir (clearwell)	0	0	0	1	0
Process Changes	1	0	1	0	1
Filter Media Inspections	0	0	0	1	1
Repairs, Replacements	1	0	0	0	1
Cleaning (reservoir, etc.)	1	0	2	0	1
Malfunctions (equipment)	1	0	0	0	1
Other	0	0	0	0	0
External Laboratory Testing (Yes)					
Plant					
Bacteria (Coliform)	1	0	0	0	1
Nitrate	0	0	1	0	0
Fluoride	0	0	0	0	0
Trihalomethanes	0	0	1	0	1
General Chemical (inorganic)	0	0	1	0	0
Heavy Metals/Trace Substances	0	0	1	0	0
Particle Counts	0	0	0	0	0
Other	0	0	0	0	0
Distribution System					
Bacteria (Coliform)	5	1	2	2	1
Nitrate	0	1	0	2	0
Fluoride	0	0	0	1	0
Trihalomethanes	3	1	0	1	0
General Chemical (inorganic)	0	0	1	2	0
Heavy Metals/Trace Substances	0	0	1	1	0
Particle Counts	0	0	0	0	0
Other	0	0	0	0	0

Table 2 (2 of 2)
QA/QC SUMMARY
Surface Supply Facilities

Population Range	<100	101-250	251-500	501-1000	1001-10000
No. of Communities	5	1	3	2	1
Records Review					
Chlorine Residuals	Op, Council, Mayor	Op	Op	Op	Op & Eng tech
Fluoride Concentrations	-	-	-	-	Op & Eng tech
Bacteriological Quantity	Op	Op	Op, SERM, Admin	Op	Op & Eng tech
Bacti Sample Submission	Op, Council	Op	Op, SERM, Admin	Op	Op & Eng tech
Turbidity	Op	Op	Op, SERM	Op	Op & Eng tech
Treatment (Yes)					
Coagulant Always Used	3	1	3	1	1
Coagulant Control (Manual)	3	1	2	1	0
Chlorine Control (Manual)	4	1	2	2	1
Dosage Adjustments Made	4	1	2	2	1
Bench Testing Equipment (jar stirrers)	0	0	1	0	1
Disinfectant Feeder					
Spare	3	0	2	0	1
Parts	1	1	2	1	1
Other Feeder					
Spare	0	0	1	1	1
Parts	0	0	2	1	1
Feeders Calibrated	0	0	0	0	1
Chemical Supplies (> 2 weeks)	4	1	3	2	1
Metering (Yes)					
Raw Water	3	0	3	2	0
Backwash	0	0	2	0	0
To Distribution	1	1	1	0	1
Calibration	0	0	0	0	1
Preventative Maintenance (Yes)					
Program in Place	0	0	1	0	1
Pump Testing	0	0	0	0	1
Valve Testing	0	0	0	0	0
Protection (Yes)					
Storage Reservoir Manways - Satisfactory	2	0	3	0	1
Truckfill - BFP	1	0	2	1	1
Cross-Connection Control Program	0	0	0	0	1
Cleaning (Yes)					
Treated Water Storage					
Annual	2	0	2	0	0
1-5 Years	3	0	0	2	1
>5 Years	0	0	0	0	0
Distribution System Flushing					
Annual or Less	2	0	3	2	1
1-5 Years	1	1	0	0	0
>5 Years	0	0	0	0	0
Distribution System Swabbing					
1-5 Years	0	0	1	0	0
5-10 Years	0	0	0	0	0
Never	3	0	1	0	1
Operators					
No. of Primary Operators	1-3	1	1	1	3
Backup (Yes)	3	1	3	1	1
Attendance					
Days Per Week					
Range	1-7	1-7	7	7	7
Hours Per Day					
Range	0.25-1	-	<1-3	-	8
Average	0.60	-	1.67	-	8
Certified (Yes)	1	0	1	0	1
External Audits (Yes)	0	0	0	0	0

Table 3 (1 of 2)
QA/QC SUMMARY
 Surface and Groundwater Supply Facilities

Community		
Population Range	501-1000	1001-10000
No. of Communities	1	2
Site Testing and Records		
Testing Equipment Available (Yes)		
Chlorine Residual	1	2
Turbidity	1	2
Colour	1	2
Iron	1	2
Manganese	1	2
Fluoride	0	2
pH	0	1
Alkalinity	0	0
Hardness	0	0
Other	0	0
Continuous Monitors (Yes)		
Turbidity	0	0
Chlorine Residual	0	0
pH	0	0
Particle Counters	0	0
Other	0	0
Equipment Calibration (Yes)		1
Adequate Testing Bench/Sink (Yes)	1	1
Frequency of Testing (PTW) (No per week)?		
Chlorine Residual T	7	7-14
Chlorine Residual F	7	7-14
Turbidity	1-7	7
Colour	1-7	0-7
Iron	7	1-7
Manganese	7	1-7
Fluoride	-	7
pH	-	0-7
Alkalinity	-	-
Hardness	-	-
Other	-	-
Records Maintenance (Yes)		
Raw Water Quantity	0	2
Treated Water Quantity	1	1
Treated Water Rate	0	0
Backwash Rate/Duration	0	1
Truckfill Quantity	0	1
System Pressure	0	1
Filter Pressures (Head loss)	0	0
Site Quality Testing	0	2
Off-site (laboratory testing)	0	0
Pump(s) Operating Hours	0	0
Chemical		
Solution Strengths	0	2
Dosages (Feeder Settings)	0	2
Daily Uses	1	2
Calculated Dosages	0	1
Physical Observations (odour, colour, clarity)		
Raw	0	0
Clarifier/Filter Influent	0	0
Filter Backwash	0	0
Filter Effluent	0	0
Reservoir (cleanwell)	0	0
Process Changes	0	0
Filter Media Inspections	1	0
Repairs, Replacements	1	2
Cleaning (reservoir, etc.)	0	2
Malfunctions (equipment)	0	2
Other	0	0
External Laboratory Testing (Yes)		
Plant		
Bacteria (Coliform)	0	1
Nitrate	0	0
Fluoride	0	0
Trihalomethanes	0	0
General Chemical (inorganic)	0	1
Heavy Metals/Trace Substances	0	1
Particle Counts	0	0
Other	0	0
Distribution System		
Bacteria (Coliform)	1	2
Nitrate	1	1
Fluoride	1	2
Trihalomethanes	0	2
General Chemical (inorganic)	1	0
Heavy Metals/Trace Substances	0	0
Particle Counts	0	0
Other	0	0

Table 3 (2 of 2)
QA/QC SUMMARY
 Surface and Groundwater Supply Facilities

Population Range	501-1000	1001-10000
No. of Communities	1	2
Records Review		
Chlorine Residuals	Op	Op
Fluoride Concentrations	Op	Op
Bacteriological Quantity	Op	Op, Admin
Bacti Sample Submission	-	Op
Turbidity	-	Op
Treatment (Yes)		
Coagulant Always Used	0	0
Coagulant Control (Manual)	0	1
Chlorine Control (Manual)	1	2
Dosage Adjustments Made	1	2
Bench Testing Equipment (jar stirrers)	0	1
Disinfectant Feeder		
Spare	1	2
Parts	1	2
Other Feeder		
Spare	1	0
Parts	1	2
Feeders Calibrated	0	1
Chemical Supplies (> 2 weeks)	1	2
Metering (Yes)		
Raw Water	1	2
Backwash	0	0
To Distribution	1	1
Calibration	0	0
Preventative Maintenance (Yes)		
Program in Place	0	0
Pump Testing	0	0
Valve Testing	0	0
Protection (Yes)		
Storage Reservoir Manways - Satisfactory	1	2
Truckfill - BFP	1	0
Cross-Connection Control Program	0	0
Cleaning (Yes)		
Treated Water Storage		
Annual	0	1
1-5 Years	1	2
>5 Years	0	0
Distribution System Flushing		
Annual or Less	1	2
1-5 Years	0	0
>5 Years	0	0
Distribution System Swabbing		
1-5 Years	0	1
5-10 Years	0	0
Never	0	0
Operators		
No. of Primary Operators	1	1
Backup (Yes)	1	2
Attendance		
Days Per Week	7	7
Range	7	7
Hours Per Day		
Range		2.5-5
Average		3.5
Certified (Yes)	1	2
External Audits (Yes)	0	0

Appendix F - Level Of Protection Model

Model

The model evaluates drinking water quality protection based on the probability that an effective protection barrier was present, as well as the importance of that barrier to ensure safe water. Relative protection is defined as a product of two factors:

$$\text{Protection} = \text{Sum of (Probability of Barrier, PB) x (Importance of Barrier, IB)}$$

The probability of barrier (PB) is defined by quantitative data using four parameters:

- | | |
|------------------------|---|
| Water source | - characteristics, protection, vulnerability. |
| Plant capability | - treatment processes, protection features. |
| Operations/maintenance | - capabilities, quality control, maintenance of system. |
| Treated water quality | - protection objectives compliance, incidence and prevalence of quality problems. |

Treated water quality is a result of the first three parameters and is the ultimate test for protection of the consumers.

A scale was established to determine the relative importance of each of the four probability parameters in ensuring effective barriers. The same scale was applied to each system. Historic quality of treated water was considered the most important factor.

The 22 parameters used in the model are shown in Appendix C for a typical community.

The model represented a significant improvement in the capability to assess protection. **However, after careful consideration, project leaders determined the available information was far too incomplete to do a proper analysis.**